220*a* may concentrate light having a first wavelength λ_1 to have a first focal length f_1. The scatterers **222***a* included in the first thin-lens **220***a* may have a shape of arrangement and interval distances appropriate to concentrate pieces of light having the first wavelength λ_1 to have the first focal length f_1. Also, the second thin-lens **220***b* may concentrate light having a second wavelength λ_2 to have a second focal length f_2. The scatterers **222***b* included in the second thin-lens **220***b* may have a shape of arrangement and interval distances appropriate to concentrate pieces of light having the second wavelength λ_2 to have the second focal length f_2. Also, the third thin-lens **220***c* may concentrate light having a third wavelength λ_3 to have a third focal length f_3. The scatterers **222***c* included in the third thin-lens **220***c* may have a shape of arrangement and interval distances appropriate to concentrate pieces of light having the third wavelength λ_3 to have the third focal length f_3.

[0106] Heights and interval distances of the scatterers **222***a*, **222***b*, and **222***c* included in the thin lenses **220***a*, **220***b*, and **220***c* may vary according to wavelength selectivities of **220***a*, **220***b*, and **220***c*, respectively. For example, interval distances between the scatterers **222***a* and heights of the scatterers **222***a* in the first thin-lens **220***a* may be smaller than the first wavelength λ_1. Also, interval distances between the scatterers **222***b* and heights of the scatterers **222***b* in the second thin-lens **220***b* may be smaller than the second wavelength λ_2. Also, interval distances between the scatterers **222***c* and heights of the scatterers **222***c* in the third thin-lens **220***c* may be smaller than the third wavelength λ_3.

[0107] FIG. **13** is a view illustrating an image sensor according to an exemplary embodiment.

[0108] Referring to FIG. **13**, the image sensor may include a light filter layer **240** configured to filter wavelength components of light incident on each of the light-sensing cells **230***a*, **230***b*, and **230***c*. The light filter layer **240** may include a plurality of light filters **240***a*, **240***b*, and **240***c*. The light filters **240***a*, **240***b*, and **240***c* may be applied in correspondence to the light-sensing cells **230***a*, **230***b*, and **230***c*. For example, a first light filter **240***a* may be configured to filter a wavelength of light incident on a first light-sensing cell **230***a*. Also, a second light filter **240***b* may be configured to filter a wavelength of light incident on a second light-sensing cell **230***b*. Also, a third light filter **240***c* may be configured to filter a wavelength of light incident on a third light-sensing cell **230***c*.

[0109] The first light filter **240***a* may transmit a predetermined wavelength component among incident light according to a wavelength selectivity of the first thin-lens **220***a*. For example, the first light filter **240***a* may allow light having a first wavelength λ_1 to transmit therethrough and reflect or absorb light of the remaining wavelength components. In the same manner, the second light filter **240***b* may allow light having a second wavelength λ_2 to transmit therethrough and reflect or absorb light of the remaining wavelength components. Also, the third light filter **240***c* may allow light having a third wavelength λ_3 to transmit therethrough and reflect or absorb light of the remaining wavelength components. Because the light filters **240***a*, **240***b*, and **240***c* filter wavelengths of incident light, noise light of undesired wavelengths may be prevented from being incident on the light-sensing cells **230***a*, **230***b*, and **230***c*. Also, quality of images obtained from the light-sensing cells **230***a*, **230***b*, and **230***c* may improve. Further, the light-sensing cells **230***a*, **230***b*, and **230***c* each generate images in different colors, and thus a multi-color image may be produced by synthesizing the images.

[0110] As described above, according to the one or more of the above exemplary embodiments, an image sensor has been described with reference to FIGS. **1** through **13**. The image sensor may concentrate pieces of incident light by using a plurality of thin lenses. In this regard, a size of the image sensor may be reduced. Also, at least one from among a plurality of operation characteristics of the thin lenses may be controlled by changing at least one from among shapes, a shape of arrangement, interval distances, and sizes of the thin lenses. Therefore, the image sensor may be easily manufactured. In addition, a 3-dimensional image, a multi-color image, and depth map information of an object may be easily obtained from imaged generated from a plurality of light-sensing cells.

[0111] The foregoing exemplary embodiments are examples and are not to be construed as limiting. The present teaching can be readily applied to other types of apparatuses. Also, the description of the exemplary embodiments is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

What is claimed is:

1. An image sensor comprising:

a substrate;

thin lenses disposed on a first surface of the substrate and configured to concentrate lights incident on the first surface; and

light-sensing cells disposed on a second surface of the substrate, the second surface facing the first surface, and the light-sensing cells being configured to sense lights passing through the thin lenses, and generate electrical signals based on the sensed lights,

wherein a first thin lens and second thin lens of the thin lenses are configured to concentrate a first light and a second light, respectively, of the incident lights onto the light-sensing cells, the first light having a different wavelength than the second light.

2. The image sensor of claim **1**, wherein the substrate comprises sub-substrates, and

the thin lenses and the light-sensing cells are respectively disposed on a first surface and a second surface of each of the sub-substrates.

3. The image sensor of claim **1**, wherein each of the thin lenses comprises scatterers, and

each of the scatterers has a pillar structure.

4. The image sensor of claim **3**, wherein an interval distance between a pair of the scatterers is less than a respective wavelength of light concentrated by a respective one among the thin lenses.

5. The image sensor of claim **3**, wherein a height of the scatterers is less than a respective wavelength of light concentrated by a respective one among the thin lenses.

6. The image sensor of claim **3**, wherein the scatterers comprise at least one from among silicon, gallium phosphide, SiC, SiN, and TiO_2.

7. The image sensor of claim **3**, wherein shapes of the scatterers and interval distances between respective pairs of the scatterers vary with a respective wavelength of light concentrated by a respective one among the thin lenses.

8. The image sensor of claim **1** further comprising light filters, each of the light filters being configured to filter a